FURUNO

OPERATOR'S MANUAL

DIGITAL TEMPERATURE INDICATOR

MODEL TI-20

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⚠ SAFETY INSTRUCTIONS

"**DANGER**", "**WARNING**" and "**CAUTION**" notices appear throughout this manual. It is the responsibility of the operator and installer of the equipment to read, understand and follow these notices. If you have any questions regarding these safety instructions, please contact a FURUNO agent or dealer.

⚠ **DANGER**	This notice indicates a potentially hazardous situation which, if not avoided, will result in death or serious injury.
⚠ **WARNING**	This notice indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.
⚠ **CAUTION**	This notice indicates a potentially hazardous situation which, if not avoided, could result in minor or moderate injury, or property damage.

⚠ SAFETY INFORMATION FOR THE OPERATOR

⚠ WARNING



Do not open the cover of the equipment.

This equipment uses high voltage electricity which can shock, burn or cause death. Only qualified personnel should work inside the equipment.

Do not dissasemble or modify the equipment.

Fire, electrical shock or serious injury can result.

Immediately turn off the power at the ship's mains switchboard if water or foreign object falls into the equipment or the equipment is emitting smoke or fire.

Continued use of the equipment can cause fire, electrical shock or serious injury.

⚠ CAUTION

Do not place liquid-filled containers on the top of the equipment.

Fire or electrical shock can result if a liquid spills into the equipmtnt.

Do not place heater neat the equipment.

Heat can melt the power cord, which can result in fire or electrical shock.

Do not operate the unit with wet hands.

Electrical shock can result.

Use the correct fuse.

Use of the wrong fuse can cause fire or equipment damage.

⚠ SAFETY INFORMATION FOR THE INSTALLER

⚠ WARNING



Only qualified personnel should work inside the equipment.

This equipment uses high voltage electricity which can shock, burn, or cause death.

Turn off the power at the ship's mains switchboard before beginning the installation. Post a warning sign near the switchboard to ensure that the power will not be applied while the equipment is being installed.

Serious injury or death can result if the power is not turned off, or is applied while the equipment is being installed.

⚠ CAUTION



Ground the equipment.

Ungrounded equipment can give off or receive electro-magnetic interference or cause electrical shock.

Confirm that the power supply voltage is compatible with the voltage rating of the equipment.

Connection to the wrong power supply can cause fire or equipment damage. The voltage rating appears on the label at the rear of the equipment.

FOREWORD

Thank you for considering and purchasing the FURUNO TI-20 Digital Temperature Indicator. We are confident that you will enjoy many years of operation with this fine piece of equipment.

For over 40 years Furuno Electric Company has enjoyed an enviable reputation for quality and reliability throughout the world. This dedication to excellence is furthered by our extensive global network of agents and dealers.

This unit is designed and constructed to ensure the user of many years of trouble-free operation. To obtain full performance from the equipment, however, you should carefully read and follow the recommended procedures for installation, operation and maintenance. No machine can perform its intended function unless it is installed and maintained properly.

We would appreciate feedback from you, the end-user, about whether we are achieving our purposes.

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FEATURES

The Furuno TI-20 Digital Temperature Indicator is designed to assist fishermen locate areas where fish may be gathered.

Water temperature is indicated in 0.01°C intervals on a large easy to read LCD (type: TI-20C) or LED (type: TI-20E) display.

The resistive platinum thermal sensor ensures accurate and reliable measurements within 0.2°C. It can be flush mounted on the hull or the engine coolant intake pipe--dry docking not necessary for installation.

In addition to its fundamental thermometer functions, the TI-20 is also equipped with the following useful functions.

- Unique temperature "TREND" indicator shows by an upward or downward arrow whether the temperature is higher or lower than the last sampled reference.
- Audible and visual alarms to alert you of changing temperature. The temperature alarm activates when the vessel has entered an operator-specified temperature zone. And the rip alarm activates when an operator-specified temperature zone is violated.
- Water surface temperature data can be output to other FURUNO instruments, or equipment that accepts NMEA-0183 format.
- With the optional Interface unit TI-2003 interfaced, history of water temperature together with the preset alarm zone may be graphically overlaid on an echo sounder.

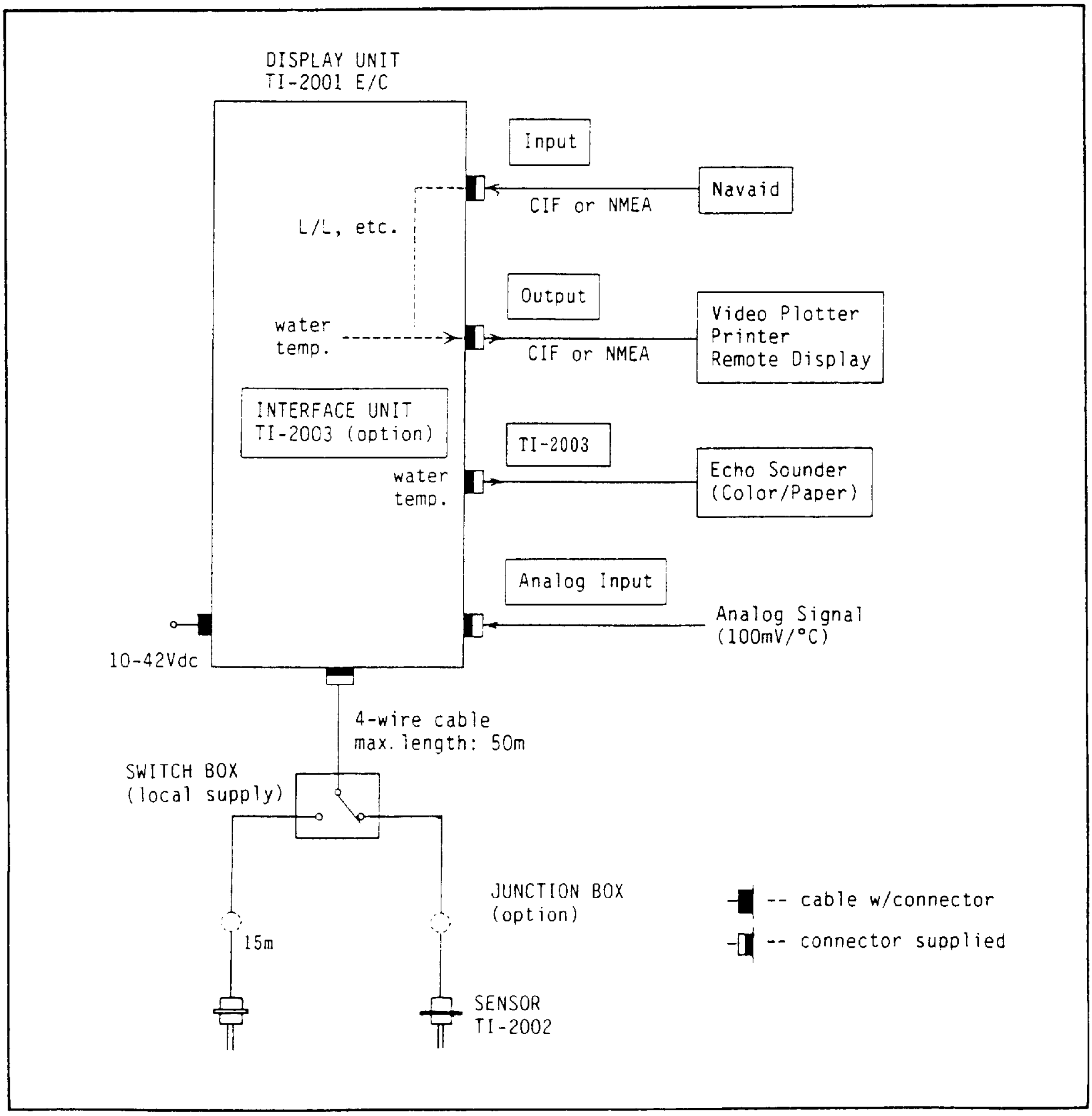
SPECIFICATIONS

1. Display	five-digit LCD Display TI-20C five-digit LED Display TI-20E
2. Display Resolution	0.01°C
3. Thermal Sensor	platinum, 100ohm (0°C), four wire
4. Measuring Range	-5°C to +40°C
5. Sampling Rate	3 times/sec (display rate: 1 time/sec)
6. Measuring Accuracy	within ± 0.2°C
7. Other Functions	marker signal can be fed to an echo sounder (Interface unit TI-2003 required)
8. Environmental Conditions	temperature sensor: -20°C - +70°C display unit: 0°C - +50°C
9. Power Requirements/Power Consumption	10-42VDC, less than 10W or 100/110/115/220VAC 50/60Hz 1ϕ, 16VA (rectifier unit required)
10. Color	2.5GY5/1.5 Newtone No. 5

SYSTEM CONFIGURATION

The TI-20 is comprised of two units: one or two thermal sensor(s) and a display unit, as shown in the system configuration diagram below. The display indication may be either LCD (TI-20C) or LED (TI-20E).

The TI-20 accepts L/L position data, etc. from a navaid, and can output it along with temperature data to a wide variety of instruments such as a video plotter, printer, echo sounder, remote display, etc. If the optional Interface unit TI-2003 is interfaced, history of water temperature can be superimposed on the display of an echo sounder. Analog input (100mV/°C) from the thermometer of other manufacturers may be interfaced.

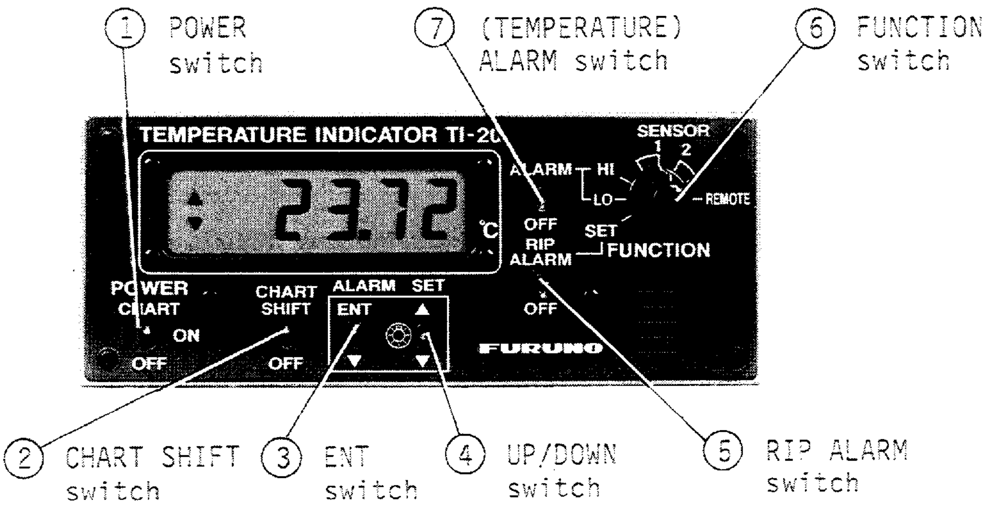


OPERATIONAL OVERVIEW

Operation of this unit is simple and straightforward, and is carried out with the controls on the front panel. The unique trend indicator shows whether the present temperature is higher or lower than the last sampled reference. Note that water temperature is indicated in °C only. For reference, °C may be converted to °F (Fahrenheit) by the following equation.

°C [x] 1.8 [+] 32 = °F

CONTROLS



N Photo No.2326

Figure 1 TI-20, Front Panel Controls

① POWER switch

This switch turns on and off the power to the TI-20 and the internal Interface unit TI-2003 (option).

② CHART SHIFT switch

When the TI-20 is interfaced with an echo sounder (using Interface unit TI-2003), the location of water temperature data may be shifted with this switch. For further details about this switch see Appendix 3.

③ ENT switch

This switch is used to register parameters for the alarms, etc.

④ UP/DOWN switch

This switch is used for alarm parameter entry and dimmer adjustment.

⑤ RIP ALARM switch

This switch turns on and off the rip alarm.

⑥ FUNCTION switch

This switch selects a display, in accordance with the table below.

⑦ TEMPERATURE ALARM switch

This switch turns on and off the temperature alarm.

Table 1 Function Switch Setting & Corresponding Display

	Function Switch Setting	Normal Display
1	Rip Alarm	setting and display of rip alarm
2	Temperature Alarm "LOw"	setting and display of "low" temp. alarm
3	Temperature Alarm "HIgh"	setting and display of "high" temp. alarm
4		sensor #1 temp. display
5	Sensor 1	sensor #1 temp. display
6	Sensor 2	sensor #2 temp. display (external analog temp. input)
7		sensor #2 temp. display
8	Remote	temp. display from external equipment

NOTE: The display mode (normal, compensation or aging) may be selected by the DIP switch S1 on the CNT board. For further details, see Appendix 1.

TEMPERATURE TREND INDICATION

There may be times when you require not momental temperature indication but rather up/down temperature trend. In such a case it may be beneficial to monitor the trend indicator, located to the left of the temperature indication. The trend indicator is comprised of an upward and a downward arrow and shows whether the current temperature is higher or lower than the sampled reference temperature by lighting one of the arrows.

The figure below shows an example of temperature change with time. Reference water temperature is stored at a specific sampling interval "t" while measuring the present temperature every 0.3 seconds for display update. The temp-up mark (▲) or temp-down mark (▼) comes on when the current temperature is higher or lower than the sampled reference temperature.

Note that the operative temp-up/temp-down mark of the LCD-type display is circumscribed by a small square (▲/▼, ▲/▼).

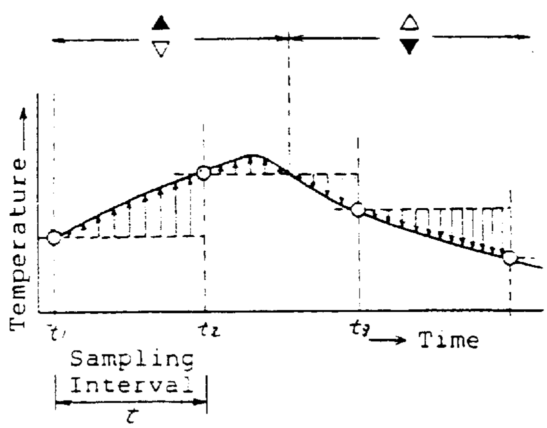


Figure 2 Temperature Change vs Trend Indication

OPERATING PROCEDURE

Operation of this unit is normally carried out in the following sequence.

POWER ON (page 4)

↓

SELF-TEST (page 5)

↓

CONTRAST/BRIGHTNESS ADJUSTMENT (page 6)

↓

SENSOR SELECTION & TEMPERATURE DISPLAY (page 6)

↓

SETTING OF RIP ALARM (page 7)

↓

SETTING OF TEMPERATURE ALARM (page 9)

↓

CHART SHIFT (TI-2003 Interface unit required) (page AP3-1)

TURNING ON AND OFF THE UNIT

The power switch at the lower left-hand corner of the unit turns on and off the power to the TI-20 and the Interface unit TI-2003.

OFF ----- Power to both the TI-20 and the TI-2003 is removed.

ON ------ Power is applied to the TI-20.

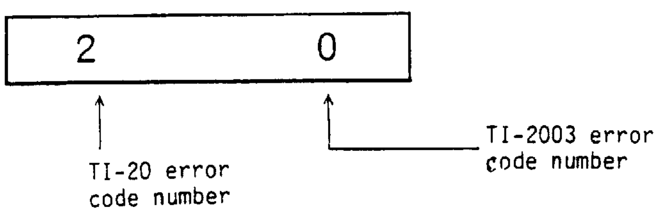
CHART --- Power to both the TI-20 and the TI-2003 is applied.

Shortly after the power is applied the unit proceeds to the self-test, in the following sequence.

Display	
0 0 0 0 0	(Display Self-Test)
⇩ · · · ⇩	
9 9 9 9 9	
. . . . .	
0 0 – –	(Program Version Number)
i n	
C i F	(Format of Input Data: CIF) see page 27
O U T	
C i F	(Format of Output Data: CIF) see page 27
S t d	
d S P	(Format of Water Temperature: DISPLAY) see page 28
2 7 . 4 0	(Water Temperature: 27.4°C)

Figure 3 Self-Test Sequence

If an abnormality is found in the TI-20 or the TI-2003, an error code is displayed. For further details about the results of the self-test, see page 14.



DISPLAY CONTRAST/BRIGHTNESS ADJUSTMENT

So that the temperature indication may be clearly viewed under all lighting and environmental conditions, display contrast (LCD) or brightness (LED) may be adjusted by the ▲/▼ switch.

LCD display contrast, because of its polarized characteristics, varies with not only the user-viewing angle but also the environmental temperature. The ▲/▼ switch is provided to equalize the degree of polarization. Three steps of contrast adjustment are available: bright, dim and off.

The LED display is adjustable in 8 steps of brightness.

To adjust the LCD contrast or LED brightness, set the FUNCTION switch to SENSOR 1, SENSOR 2 or REMOTE; then press the ▲/▼ switch to obtain the desired level.

SENSOR SELECTION AND TEMPERATURE DISPLAY

The FUNCTION switch is used to display water temperature data derived from sensor 1, sensor 2 or external equipment.

FUNCTION switch setting	Displayed Water Temp.
Sensor 1	water temp. from sensor 1
Sensor 2	water temp. from sensor 2
Remote	water temp. from external equipment

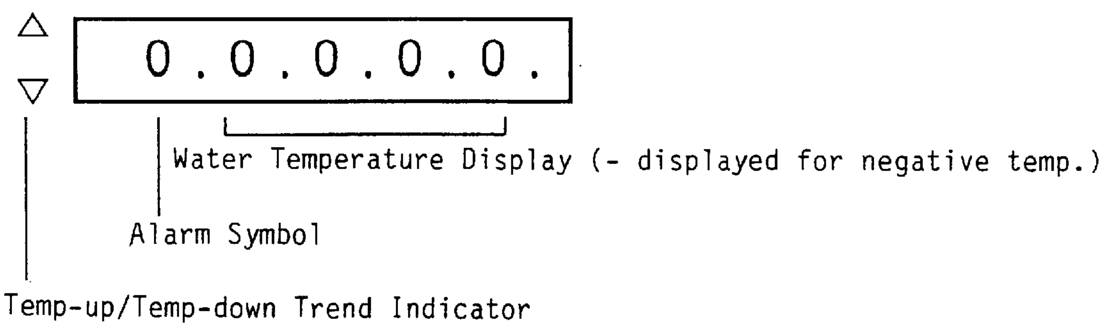


Figure 4 Display Window

ALARMS

There are two conditions which can trigger audible and visible alarms in the TI-20: the rip alarm which activates when an operator-specified temperature zone is violated, and the temperature alarm which is generated when the vessel has entered an operator-specified temperature zone.

When a preset value is breached, audible (temperature alarm: continuous; rip alarm: intermittent, automatically ceases after 10 sec.) and visual alarms (shown below) are activated. In the case where both alarms are activated, which alarm is sounding can be ascertained by noting the displayed symbol.

blinking: rip alarm

blinking: temperature alarm (high)

blinking: temperature alarm (low)

blinking: temperature within preset range

Figure 5 Visual Alarm Symbols

To stop the audible and visual alarms, set the appropriate alarm switch to off.

Rip Alarm

The rip alarm, which activates whenever the operator-set temperature zone has been breached, may be used to detect current rips. Current rips, caused along sea streams/currents or at their junction, are often an indication of the presence of dense fish shoals. They may be detected by carefully watching for ripples or coloration of the sea surface, or by observing plankton layers on the echo sounder. However, it is more accurate and a lot easier to find it by detecting a sudden change in water temperature.

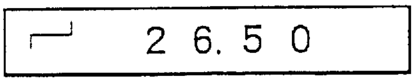
1. Place the FUNCTION switch in the SET position. A temperature variation rate, the amount of temperature deviation which will activate the alarm, is displayed. If the unit is turned on for the first time the factory-set rate, 0.50, is displayed.

   0. 5 0

2. Using the ▲/▼ switch, set a temperature variation rate (settable range: 0.00°C-0.50°C).

3. Push down the ENT switch to register the temperature variation rate. The alarm sounds for 3 seconds.

4. When the alarm activates the display looks something like the one below, showing present temperature and alarm symbol. If the alarm (audible & visual) is not stopped within 10 sec. it ceases automatically. The figure below shows how the rip alarm is activated by changes in water temperature.



RIP ALARM ACTIVATION

Reference water temperature is stored at a specific sampling interval "t" (1 minute), while measuring the present temperature every 0.3 seconds for display update. The rip alarm will be released for the period when the present temperature is higher or lower than the last sampled reference by more than a specific amount, namely, "g", thermal gap.

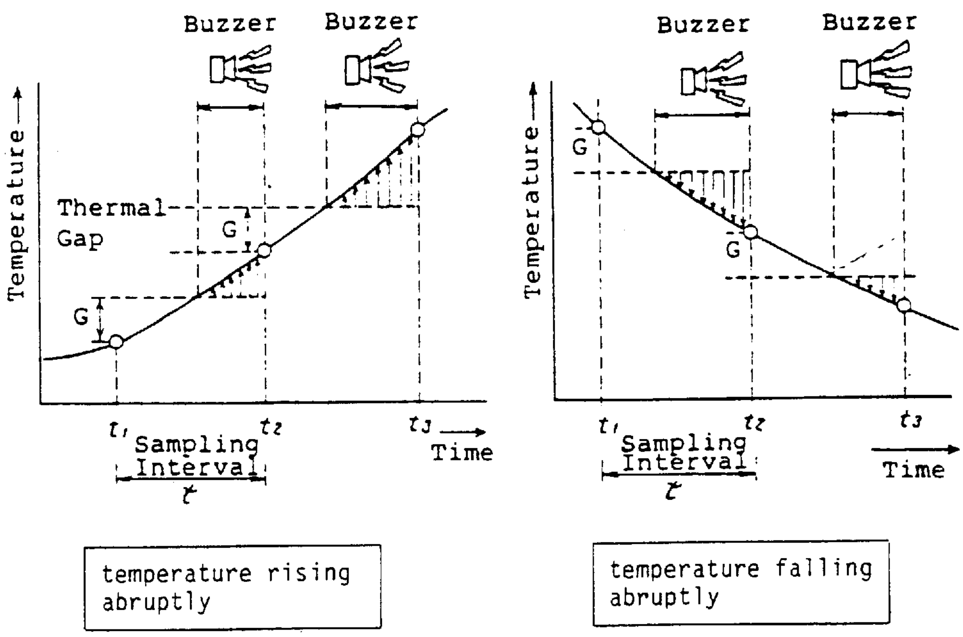


Figure 6 Rip Alarm Activation

Temperature Alarm

The temperature alarm is used to alert that the vessel has entered a temperature zone which is higher, lower or within the operator-specified temperature zone. This alarm may be used to track a particular fish species, since each fish species has its own inhabitable temperature range. For further details about the inhabitable temperature ranges of specific fish species see the table on page AP4-1.

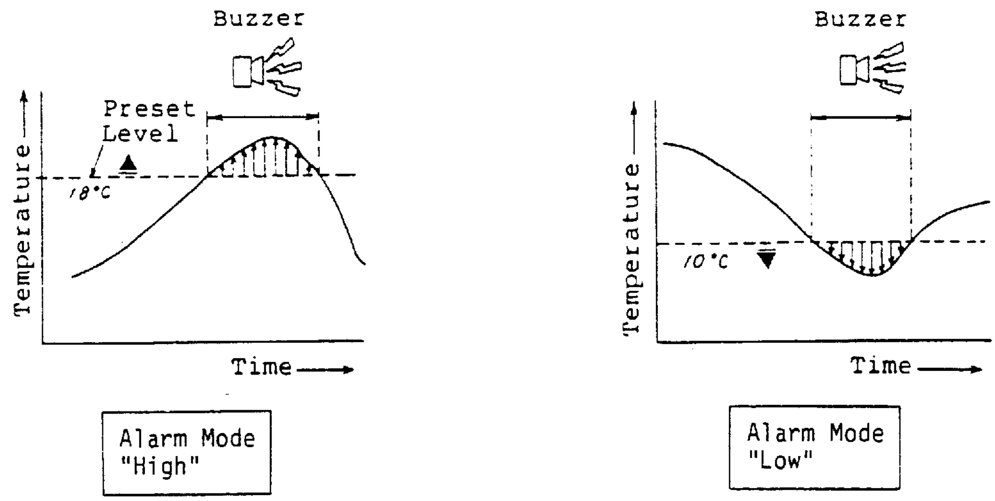


Figure 7 Temperature Alarms

"High" Alarm

The "high" temperature alarm may be used when you want to be notified that the water temperature is higher than the preset temperature.

1. Place the FUNCTION switch in the HIGH position. The display should look something like the one shown below.

⊔ 40.00

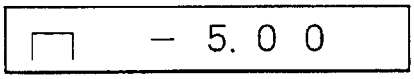
2. With the ▲/▼switch, set the desired alarm temperature (settable range -5.00-40°C; factory setting, 40.0°C).

3. Press the ENT switch to register the temperature set in step 2. The alarm sounds, and stops automatically after 3 seconds.

"Low" Alarm

The low alarm can notify you when water temperature is lower than the preset temperature.

4. Place the FUNCTION switch in the "LOW" position. The display should look something like the one below.



5. With the ▲/▼ switch, display the desired alarm range (-5.00°C to 40.00°C, factory setting: -5.00°C).

6. Press the ENT switch to register the range set in step 5. The alarm sounds, and stops automatically after 3 seconds.

TEMPERATURE ALARM ACTIVATION RANGE

As a general rule of thumb, the upper limit (high) of the alarm is set lower than the lower limit (low), which would activate the alarm if the temperature goes between the two limits (see the left-hand figure below). However, if you want the alarm to be generated when the temperature goes out of the preset temperature range, set the upper and lower limits contrariwise (see the right-hand figure below).



a) upper limit=5.00°C
< lower limit=10.00°C

b) upper limit=10.00°C
> lower limit=5.00°C

: (alarm range)

Figure 8 Temperature Alarm Activation Range

TEMPERATURE DISPLAY CORRECTION (Technician only)

Discrepancy between the displayed water temperature and the actual water temperature may be corrected by DIP switch S1 on the CNT board.

1. After removing the cover, locate the CNT board (see the figure below). Set #1 and #2 of DIP switch S1 to ON and OFF, respectively; then turn the power on.

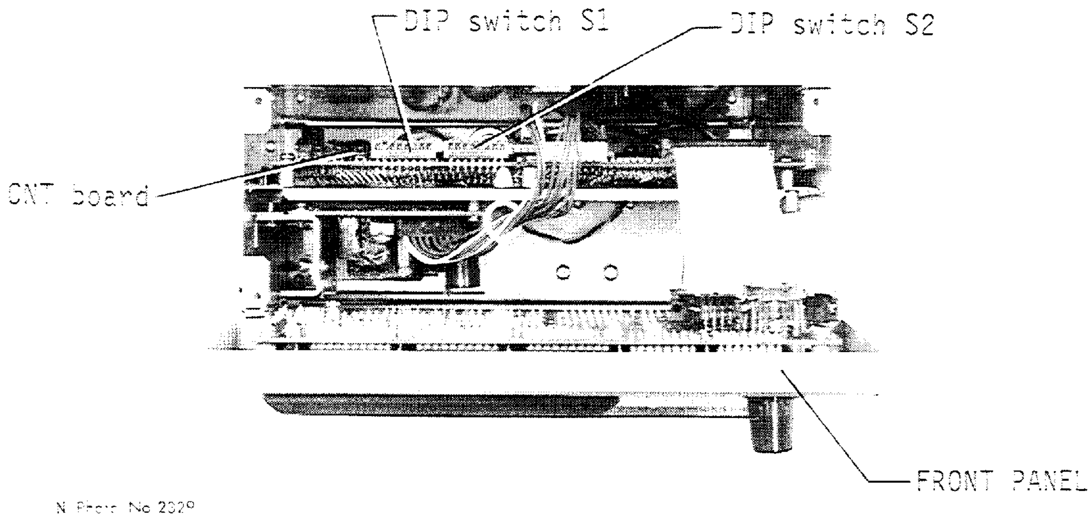


Figure 9 Location of the CNT board

2. Place the FUNCTION switch in the SENSOR 2 position. The display should appear as shown below.

0 –	➡	0 0 . 0 0
about 1 sec.		operative temperature offset

3. With the ▲/▼ switch, display the offset desired. Note that if the switch is pressed and hold for 4 or 8 seconds, the interval of change will be 0.1°C and 1°C, respectively.

4. Press the ENT switch to register the offset set in step 3. If the Printer FP-70 is interfaced, the offset is indicated on the print out.

5. Set both #1 and #2 of DIP switch S1 to OFF; then turn off the unit.

6. Replace the cover.

CLEARING THE MEMORY

When you want to clear all settings stored in the memory; namely, to restore factory settings, follow the procedure below.

1. After removing the cover, locate the CNT board (see page 11). Set #1 and #2 of DIP switch S1 to ON and OFF, respectively; then turn the power on.

2. Set the FUNCTION switch at each of its positions and record the value displayed, using the table provided below. (This step may be omitted if the FURUNO Printer FP-70 is interfaced.)

Table 2 Data Stored in the Memory Block

	Function Switch Position	Display Item	Displayed Value	
1	Rip Alarm	#1-1 sensor resistance in ohms @ 0°C		
2	Alarm "LO"	#1-2 sensor resistance in ohms @ 0°C		
3	Alarm "HI"	temp. measuring circuit slope/ compensation (COMP 1)	—	—
4		temp. measuring circuit slope/ compensation (COMP 2)	—	—
5	Sensor 1	temp. measuring circuit offset (COMP 3)	—	
6	Sensor 2	water temperature offset		
7		temp. measuring circuit slope		
8	Remote	temp. measuring circuit slope offset		

3. Turn the power off and after setting # 1 and # 2 of DIP switch S1 to OFF and ON respectivery, turn the function switch to SENSOR 2, and reapply the power.

4. IF error number 3 is displayed after performing the self-check, push down the ENT swith. The following is displayed after program version is displayed.

A L L	⟷	C L r

5. Push down the ENT switch. The alarm sounds and the following is displayed.

O ト	(OK)

6. Push down the ENT switch again. Shortly thereafter "DONE" is displayed, indicating the memory is cleared.

7. Manually reenter slope and offset, following the procedure prescribed in Appendix 2.

DATA PRINTING

If the TI-20 is interfaced with the FURUNO Printer FP-70, data stored in the memory can be printed out.

1. Turn the power off. After gaining access to the CNT Board (see page 11), set #1 and #2 of DIP switch S1 to OFF and ON, respectively.

2. Place the FUNCTION switch in the SENSOR 1 position. The indicator "Print" is displayed.

3. Push down the ENT switch to begin printing. An example print-out is shown below.

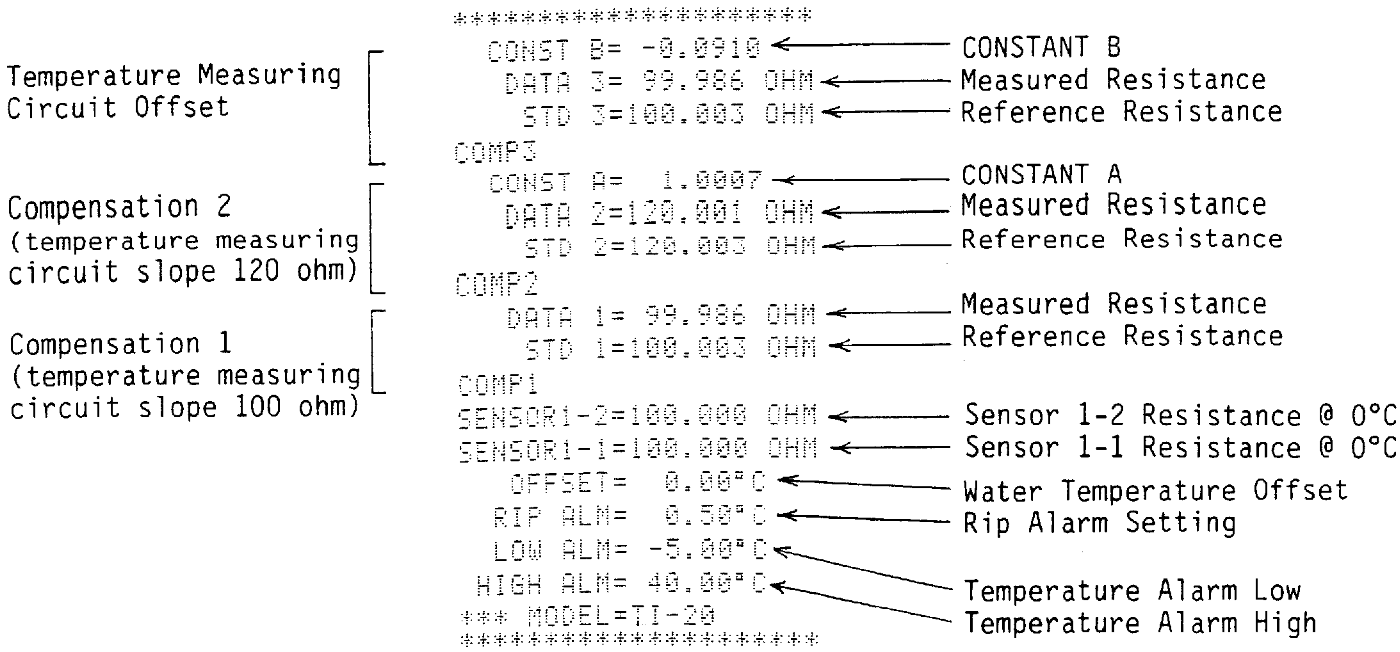


Figure 10 Data Print-out

SELF-TEST

Each time the power is applied a self-test of the TI-20 and the TI-2003 (option) is performed. If an abnormality is detected an error code is displayed (see below). Note that in the case of multiple abnormalities only the lowest error code is displayed. Should you suspect there may be multiple abnormalities each press of the ENT switch will display the error code corresponding to the defective component (if any).

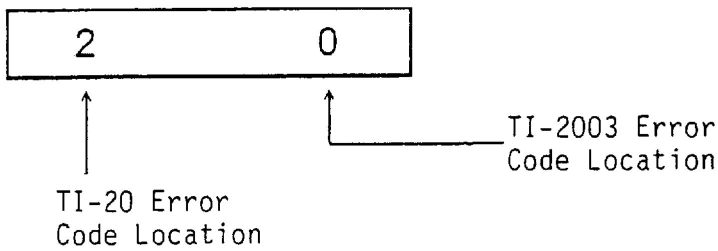


Table 3 Error Code and Associated Defect

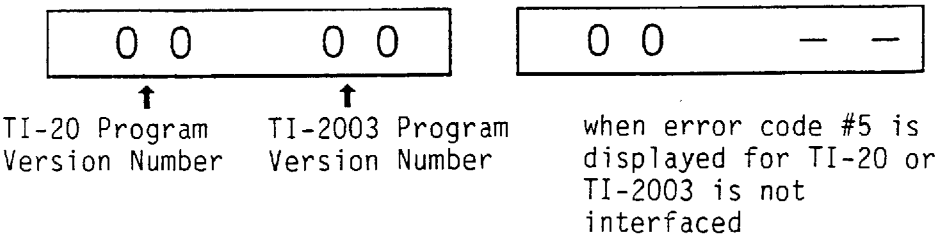
Error Code	TI-20	TI-2003
0	Normal	Normal
1	Defective ROM	Defective ROM
2	Defective RAM	Defective RAM
3	Memory Error †1	Defective 8254, #1
4	Dual Port RAM Error †2	Defective 8254, #2
5	A/D Converter Error	Defective 8254, #3
6	SIO Error	

†1 Ensure that data in the memory has been entered correctly and is within the permissible range.

†2 If dual port RAM is the only error displayed, the program number is displayed.

PROGRAM NUMBER

The program version number of the TI-20 and the TI-2003 are displayed for 2 seconds after the self-test. The program version number is not displayed when error code "5" (A/D Converter error) is displayed for the TI-20 or the TI-2003 is not incorporated.



MAINTENANCE

REGULAR MAINTENANCE

Good performance depends on regular maintenance. Following the checks prescribed below will not only keep the unit operating in top condition and prevent unexpected malfunctions but will also lengthen equipment life.

Table 4 Maintenance Schedule

Check Interval	Check Point	Procedure	Caution
1-2 weeks	front panel and chassis	Accumulated dust or dirt should be wiped off with water-diluted mild detergent and a soft cloth. Apply the solution sparingly, wiping it off with light pressure only.	Never use acetone or thinner. These may dissolve paint or markings.
2-3 years or when dry docked	sensor	Thru Hull Remove marine growth around the sensor with a soft brush. If growth is heavy loosen the cap nut to clean the sensor. (Replace the packing at this time.)	Do not paint the sensor head. NEVER CLEAN THE SENSOR BY SAND BLASTING OR PRESSURIZED WATER.
		Intake Pipe Take sensor element out of sensor mount and clean. Replace packing.	
3-5 years	packing	Dismount the sensor element and replace the packing. (type: 14-035-3101)	Any time the cap nut is loosened the packing must be replaced.

FUSE REPLACEMENT

A fuse is provided on the rear panel to protect the unit from overcurrent. If the fuse blows, replace it with the fuse provided (FGMB, 2A). NEVER USE A FUSE RATED HIGHER THAN 2A SINCE IT MAY CAUSE SERIOUS DAMAGE TO THE EQUIPMENT.

⚠ CAUTION

Use the proper fuse.

Use of the wrong fuse can result in fire or permanent equipment damage.

LIFE OF THE LCD PANEL (display type: TI-20C)

The LCD (Liquid Crystal Display) panel lasts approximately 50,000 hours under normal use (approx. 5 years continuous use). However, as its life can be shortened by heat or ultraviolet light rays, care must be taken to keep the indicator away from these harmful sources.

If the display quality has degraded (poor contrast, narrow viewing angle), ask your dealer or service agent about panel replacement.

INSTALLATION

SENSOR UNIT INSTALLATION GUIDELINES

The sensor unit is usually installed on the hull bottom, however, it may be installed on the intake pipe of the vessel's engine cooling system. Hull bottom installation, which offers the greatest degree of temperature measuring accuracy, entails dry docking. Intake pipe installation does not require dry docking, however measuring accuracy is somewhat reduced.

The type of sensor depends on the type of installation and is given in the table below.

Type of Installation	Type of Sensor
steel hull	TI-2002T
FRP hull	TI-2002F
steel intake pipe	TI-2002TP

NOTE: A sensor unit especially designed for installation on a copper intake pipe is available by special order.

Sensor Data Label

Following installation, calibration of the display unit is required. A sensor data label, shown below, is affixed to the sensor and shows serial number and sensor resistance in ohms @ 0°C. This resistance is required for post-installation calibration purposes and should be recorded in the table provided on page 12.

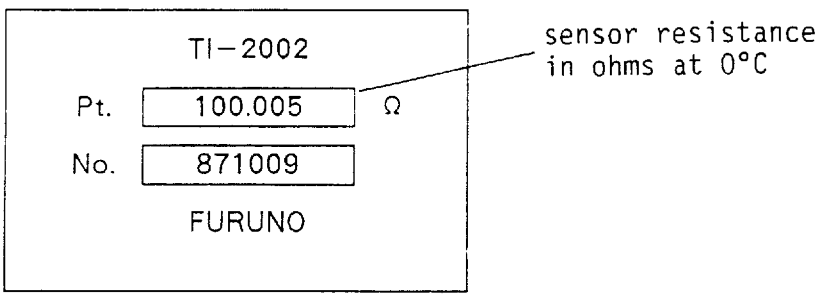


Figure 11 Sensor Data Label

Sensor Handling Precautions

* Never swing the sensor by the sensor cable.

* Do not drop or throw the sensor (force greater than 5kgf/cm2 may permanently damage the sensor).

* Do not pull the cable while holding the sensor.

Installation Site

The installation site greatly determines unit performance. When selecting the installation site, keep the following points in mind.

- For installation on the hull bottom, select a mid-boat flat position. The sensor installation angle does not have to be perfectly perpendicular.
- The maximum length of the sensor cable is 50m.
- Keep the sensor away from heat-emitting equipment.
- Select a site in the forward direction viewing from the drain hole for cooling water.
- For installation on the intake pipe, mount the sensor on the lower wall of the pipe at the horizontal portion where the sensor always soaks in water.

INSTALLATION ON THE HULL BOTTOM (sensor type: TI-2002T or TI-2002F)

As noted on the preceding page this type of installation provides the greatest degree of temperature measuring accuracy.

Before beginning the installation, take note of the following.

1) Take necessary waterproofing, reinforcement and anti-corrosion measures on the installation site.

2) Remove all fitting such as the sensor element, packing, etc. prior to welding the sensor mount.

3) Great care should be taken not to damage the threads of the sensor mount.

TI-2002T (Steel Hull)

1. Drill a hole of approx. ϕ63mm through the hull and the doubling plate.
2. Align the hole on the doubling plate with the hole in the hull; then weld (not spot welding) the plate to the hull.

3. Insert the sensor mount into the hole, align the sensor protector so that it is nearly perpendicular to the vessel's bow, then weld the sensor mount to the hull. (The "H" mark should be aligned with the vessel's bow.)

TI-2002F (FRP Hull)

1. Drill a hole of approx. ø71mm through the hull and doubling plate.
2. Insert the sensor mount through the hull. Insert doubling plate, packing, flat washer and lock nut in this order. Align the sensor protector so that it is nearly perpendicular to the vessel's bow. (The "H" mark should be aligned with the vessel's bow.)
3. Tighten the lock nut (2), and carry out FRP treatment inside and outside the hull bottom.

SENSOR ELEMENT INSTALLATION (Steel Hull/FRP Hull)

Before beginning the installation take note of the following.

1) Do not apply excessive pressure to the sensor.
2) Do not pull the sensor cable.
3) Do not overtighten the cap nut.
4) Never paint the surface of the sensor.
5) Carefully remove barnacles and other marine growth from the sensor whenever the vessel is drydocked. NEVER CLEAN THE SENSOR BY SAND BLASTING OR PRESSURIZED WATER.

Procedure

1. Screw the lock nut onto the sensor mount.
2. Clean the sensor cable, and pass its end through the packing and flat washer, and then the sensor mount from inside the hull bottom. Do not pull the sensor cable with excessive force from inside the hull bottom. (load force: 2kgf or less)
3. Run the sensor cable through the packing and flat washer.
4. After confirming that the packing and flat washer are correctly inserted, tighten the gland (tightening torque: more than 200kgf-cm). The gland should be in contact with the upper part of the sensor mount.
5. Apply sealing compound to the screw of the cap nut, and then screw the cap nut into the sensor mount.
6. Turn the lock nut counterclockwise to fix the cap nut.

INSTALLING THE WATERPROOF PIPE/HOSE

A waterproof pipe or hose should be fixed to the cap nut to preserve watertight integrity and electrically shield the sensor cable.

When installing the pipe or hose keep the following points in mind.

* An upper end of the waterproof pipe or hose should be located above the load draught.

* Apply a waterproof cap or putty to the end of the pipe.

* Be careful not to damage the cable during installation of the pipe.

* Ground the pipe.

Procedure

1. Apply two turns of sealing tape to the thread of the waterproof pipe; then screw the pipe into the cap nut.

2. Ground the pipe.

NOTE: If piping is not feasible, use a nipple (supplied as installation materials) and a vinyl hose (arranged locally). In this case, however, complete electrical shielding cannot be expected.

INSTALLATION ON THE INTAKE PIPE (sensor type: TI-2002TP)

Installation on the intake pipe of the engine cooling system, although offering installation ease, does not provide the same temperature measuring accuracy as does the hull bottom installation.

Before beginning the installation please note the following.

- Select a sensor unit mounting location on the lower wall of the intake pipe (see below) at the horizontally running portion where the sensor always soaks in water.

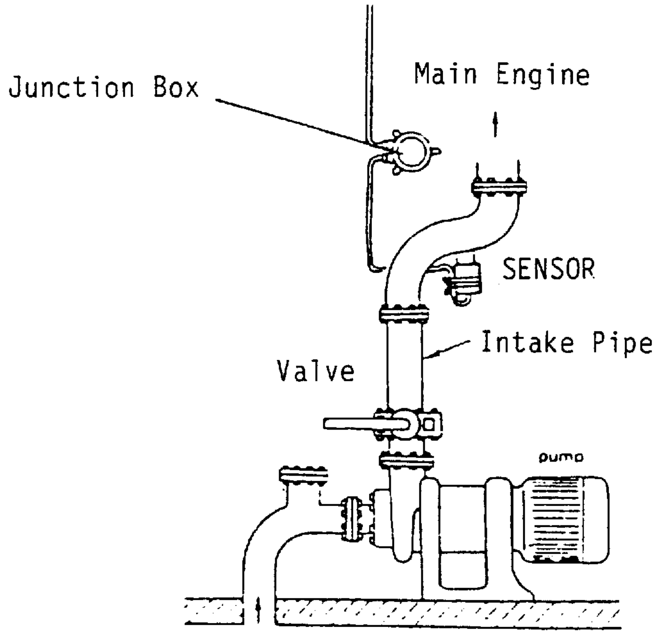


Figure 12 Locating the Sensor on the Intake Pipe

- Remove fittings such as the sensor, packing, etc. before beginning any welding operations.
- Do not overtighten the fixing gland or the cap nut.
- Do not throw, drop or swing the sensor unit/element. Excessive force may permanently damage the sensor unit.
- The sensor cable may be damaged if it is pulled with excessive force.

Procedure

1. Drill a hole of approx. ϕ41mm in the intake pipe.
2. Insert the sensor mount through the hole and weld it in place.
3. Install the sensor element following the steps prescribed on page 20, "Sensor Element Installation."
4. Fix the sensor cable to the cap nut with rope, etc.

SENSOR SWITCH BOX

A switch box (local supply) is required if two sensors are connected. The circuity of the switch box should be constructed as shown on the next page. The enclosure itself should be of environmentally sealed construction to keep out harmful contaminants such as dirt and dust.

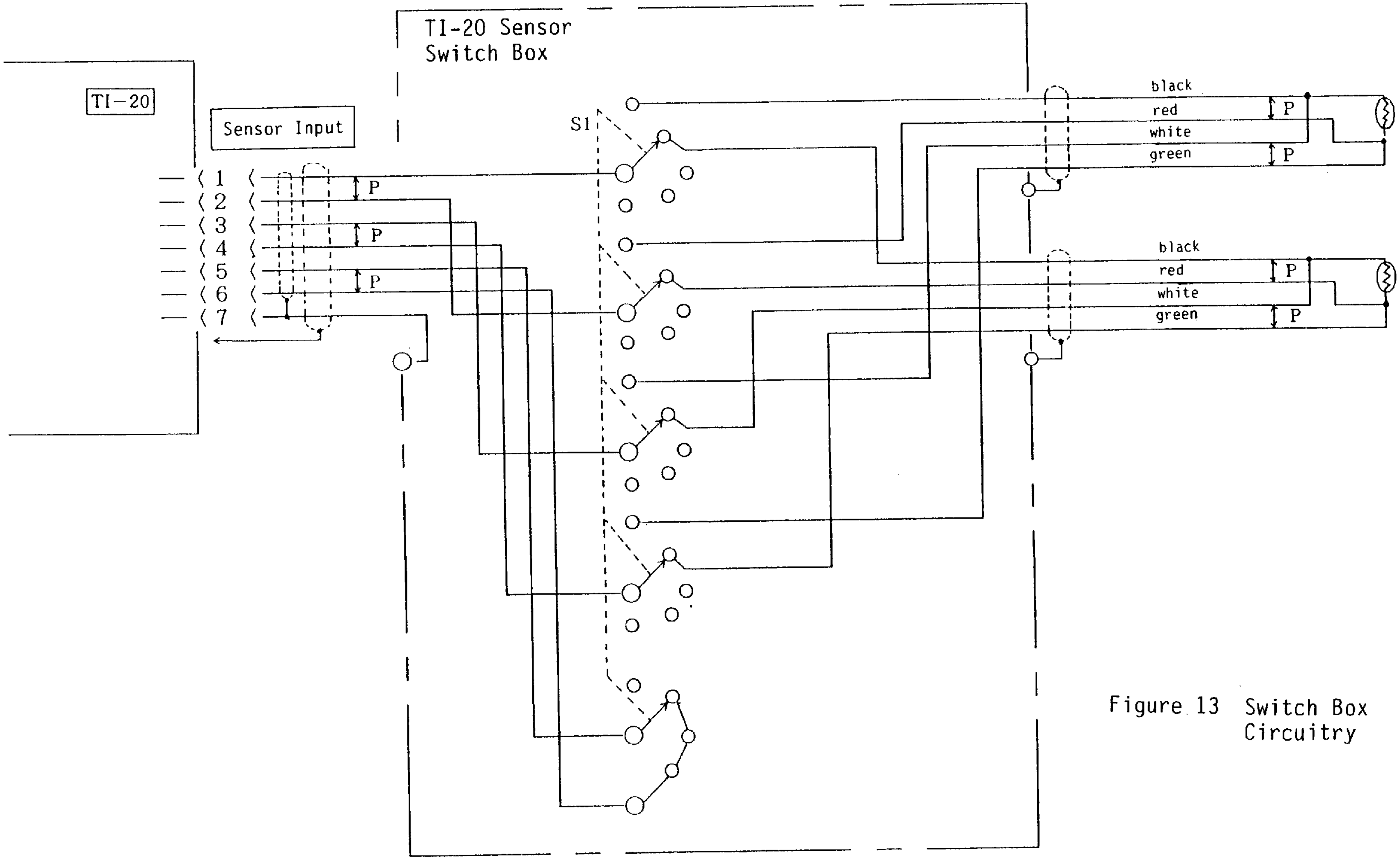


Figure 13 Switch Box Circuitry

- The enclosure itself should be of environmentally sealed construction to keep out harmful contaminants.

DISPLAY UNIT INSTALLATION

The display unit is carefully constructed to be able to withstand the humidity and corrosive environment common in the marine environment, but it is not designed to be used outside, directly exposed to that environment. Salt water spray will most assuredly cause damage to the sensitive components inside. Keep these and the following factors in mind when planning the installation of the display unit.

CAUTION

FURUNO will assume no responsibility for the damage caused by exposure to either fresh or salt water.

- Even though the display is quite legible in direct sunlight, ensure the mounting location is out of direct sunlight or at least shaded because of heat that can build up inside the cabinet. If the LCD display is used, exposure to ultraviolet light or heat sources will shorten the life of the panel, so select a location not influenced by these harmful sources.
- Consideration should be made to provide space for access to the mounting hardware on the side and the connectors behind the display unit. Also allow at least a foot or so of "service loop" in the cables to allow the unit to be pulled forward for servicing or internal adjustment.

Procedure

The swivel mount mounting bracket permits installation on a tabletop or overhead.

1. Loosen the knob screw at each side of the mounting bracket, and separate the bracket from the display unit.
2. Mark screw locations by using the mounting bracket as a template.
3. Fix the bracket to the planned position with the four tapping screws supplied.
4. Fit the display unit in the bracket. Tighten the knobs.

SYSTEM CALIBRATION

Following installation of the sensor unit and the display unit and cable fabrication and connection, the TI-20 must be calibrated according to sensor resistance in ohms @ 0°C, data input and output formats of interfaced equipment, etc. This is done with the DIP switches and the jumpers on the CNT board.

Sensor Resistance

If the installation instructions were followed faithfully sensor resistance in ohms @ 0°C (recorded on the label attached to the sensor element) should be recorded on the table on page 12. This value will now be used for system calibration.

1. Turn the power off (if on). Locate DIP switch S1 on the CNT board (for the location, see page 11) and set #1:ON and #2:OFF. Turn the power on.

2. Place the FUNCTION switch in the SET position. The following is shown on the display.

S E n S r	about 1 sec.
↓	
1 – 1 0	about 1 sec.
↓	
0 0 . 0 0 0	resistance (100.000 ohm)

3. With the ▲/▼ switch, set the resistance. If the resistance is 100.005 ohms, for example, display 00.005.

4. Register the resistance by pressing the ENT switch. The alarm activates for 3 sec. and then shuts off automatically. Turn the power off, set #1 and #2 of DIP switch S1 to OFF, and then reapply the power.
   If two sensors are installed enter the resistance of sensor #2, following steps 5 and 6.

5. Set the FUNCTION switch to the ALARM LOW position. The following is shown on the display.

S E n S r	about 1 sec.
↓	
1 – 2 0	about 1 sec.
↓	
0 0 . 0 0 0	resistance (100.000 ohm)

6. Enter and register the resistance of sensor #2.

Format of Input Data

The TI-20 accepts one of four types of input data formats as shown in the table below. Set #3 and #4 of DIP switch S1 according to the format of the interfaced navaid.

S1		Types of Input Data	Display at Power ON
#3	#4		
OFF	OFF	CIF (factory setting)	CiF
ON	OFF	NMEA-0183	nMEA
OFF	ON	TI-11D format	till
ON	ON	not used	

Format of Output Data

Set #5 and #6 of DIP Switch S1 according to the data format of the interfaced color video plotter, echo sounder, etc.

S1		Types of Output Data	Display at Power ON
#5	#7		
OFF	OFF	CIF (factory setting)	CiF
ON	OFF	NMEA-0183	nMEA
OFF	ON	TI-11D format	till
ON	ON	not used	

Water Temperature Output

#7 and #8 of DIP switch S1 determine how water temperature and alarm data are fed to interfaced equipment. Note that water temperature offset is applied only to water temperature derived from sensor 1.

S1		Water Temperature Output	Display at Power ON
#7	#8		
OFF	OFF	according to FUNCTION switch setting (factory setting)	dSP
ON	OFF	water temperature from sensor 1	SnSr1
OFF	ON	water temperature from sensor 2 (analog sensor, 100mV/°C)	SnSr2
ON	ON	water temperature data (CIF/NMEA 0183/TI-11D format) output along with input data	CiF, nMEA or till

Selection of Display Indication

The display indication is either LED or LCD. Set DIP switch S2 #2 accordingly. (DIP switch S2 is adjacent to DIP switch S1 on the CNT board).

S2 #2	Type of Display
OFF	TI-20E (LED)
ON	TI-20C (LCD)

Interface Unit

Set #3 of DIP switch S2 according to whether or not the Interface unit TI-2003 is connected or not.

S2 #3	TI-2003 (Y/N)
OFF	NO
ON	YES

Jumper Selection

Jumpers JP2 and JP3 must be set according to output and input formats, respectively.

Jumper	CIF	NMEA
JP2 (output)	open	short
JP3 (input	short	open

TI-20 INPUT AND OUTPUT DATA FORMAT

CIF

a. 4800 baud

b. 1 start bit, 7 data bits, even parity, 2 stop bits

c. input interval: in accordance with interfaced instrument

d. output interval: in accordance with interfaced instrument at input side (when there is no input, every two seconds)

NMEA-0183

a. 4800 baud

b. 1 start bit, 8 data bits, non-parity, 1 stop bit

c. input interval: in accordance with interfaced instrument

d. output interval: in accordance with interfaced instrument at input side (when there is no input, every two seconds)

TI-11D

a. 4800 baud

b. 1 start bit, 7 data bits, even parity, 2 stop bits

c. input interval: in accordance with interfaced instrument

d. output interval: in accordance with interfaced instrument at input side (when there is no input, every two seconds)

APPENDIX 1 OPERATING MODES

There are three operating modes, normal, compensation and aging (factory use), and which is in effect is determined by the setting of DIP switch S1 on the CNT board. The relation among DIP switch setting/Mode/FUNCTION switch setting is given in the tables below.

Table A1 DIP Switch Setting and Corresponding Operating Mode

S1		Operating Mode
#1	#2	
OFF	OFF	Normal mode
ON	OFF	Compensation mode
OFF	ON	Aging mode
ON	ON	not used

Table A2 Relation Among FUNCTION Switch/Operating Mode/Display Contents

Switch Position	Normal Mode	Compensation Mode	Aging Mode
1	Rip Alarm	Sensor 1-1 Resistance	(Aging Mode, factory use)
2	Temp. Alarm HI	Sensor 1-2 Resistance	(TI-20 SW Test)
3	Temp. Alarm LO	(COMP 1) *1	(TI-2003 SW Test)
4		(COMP 2) *2	Recorded Data Display
5	Sensor 1	(COMP 3) *3	Data Printing
6	Sensor 2	Water Temp. Offset	Memory Clear
7		CONST A *4	(Raw Data)
8	Remote	CONST B *5	(Not used)

NOTE: items in parenthesis not normally used.

* 1 measuring circuit slope correction 1

* 2 measuring circuit slope correction 2

* 3 measuring circuit offset

*4 measuring circuit slope--manual setting

*5 measuring circuit offset--manual setting

APPENDIX 2 COMPENSATIONS

Sensor calibration and display unit (temperature measuring circuit) compensation may be made through the front panel controls of the TI-20. Some adjustments have been made at the factory, while others may be made locally, such as temperature offset.

- SENSOR ------------- sensor resistance in ohms @ 0°C (after installation or sensor replacement)

- DISPLAY UNIT ------- (1) temperature measuring circuit slope compensation 1 (factory preset)

  (2) temperature measuring circuit slope compensation 2 (factory preset)

  (3) temperature measuring circuit offset (locally; standard 100 ohm resistor required)

  (4) temperature offset (locally)

  (5) temperature measuring circuit slope (after memory clear)

  (6) temperature measuring circuit offset (after memory clear)

To perform calibration/compensation, set #1 of DIP switch S1 on the CNT board to ON (compensation mode). After completion, set #1 to OFF, then turn off and on the power.

(1) TEMPERATURE MEASURING CIRCUIT SLOPE COMPENSATION 1 (factory preset)

This setting has been factory preset and thus re-setting is not normally required.

1. Connect a standard 100 ohm resistor 1 (97.000 ohm - 100.000 ohm) to the sensor terminal on the rear panel.
2. Place the FUNCTION switch in the HIGH position. The display should appear something like the one below.

CmP 10	➡	00.000
about 1 sec.		reference resistance 1 (hundredths place not displayed)

3. With the ▲/▼switch set the resistance (display reading with the resistor connected). Pressing and holding the switch for 4 seconds or more will yield 0.01 increments, while holding it down for more than 8 seconds will yield 0.1 intervals.
4. Push down the ENT switch; the alarm sounds, confirming registration.
5. Shortly thereafter a message similar to the following one is displayed.

CmP 11	➡	99.993	(99.993 ohms)
about 1 sec.		measured resistance 1 (hundredths place not displayed)	

6. Press down the ENT switch; the alarm sounds, sampling begins and the display is counted up from 1 to 99.
7. When sampling is finished, the result of the measurement is displayed.

99.994	(99.994 ohms)

(2) TEMPERATURE MEASURING CIRCUIT SLOPE COMPENSATION 2 (locally)

This setting has been factory preset and thus re-setting is not normally required.

1. Connect a standard 120 ohm resistor 2 (117.000 ohm - 123.000 ohm) to the sensor terminal on the rear panel.
2. Place the FUNCTION switch in the "SENSOR 1" position (switch position #4). The display should look something like the one below.

CmP 20	➡	20.000	(120.000 ohms)
about 1 sec.		reference resistance 2 (hundredths place not displayed)	

3. With the▲/▼switch set the resistance (display reading with the resistor connected). Pressing and holding the switch for 4 seconds or more will yield 0.01 increments, while holding it down for more than 8 seconds will yield 0.1 intervals.
4. Push down the ENT switch; the alarm sounds, confirming registration.
5. Shortly thereafter a message similar to the following one is displayed.

CmP 21	➡	20.002	(120.002 ohms)
about 1 sec.		measured resistance 2 (hundredths place not displayed	

6. Press down the ENT switch; the alarm sounds, sampling begins and the display is counted up from 1 to 99.
7. When sampling is finished, the result of the measurement is displayed.

19.998	(119.998 ohms)

(3) TEMPERATURE MEASURING CIRCUIT OFFSET (locally, 100 ohm resistor required)

Adjustment of the temperature measuring circuit may be made as required (usually yearly). The adjustment requires the connection of a 100 ohm resistor, which allows resistance offset to be processed by the internal computer.

1. Connect the resistor (95.000 ohm - 105.000 ohm) to the sensor terminal.
2. Place the FUNCTION switch in the SENSOR 1 position (switch position #5). The display should look something like the one below.

CmP 30	➡	00.000
about 1 sec.		reference resistance (hundredths place not displayed)

3. With the ▲/▼ switch set the resistance (display reading with the resistor connected). Pressing and holding the switch for 4 seconds or more will yield 0.01 increments, while holding it down for more than 8 seconds will yield 0.1 intervals.
4. Push down the ENT switch; the alarm sounds, confirming registration.
5. Shortly thereafter a message similar to the following one is displayed.

CmP 31	➡	99.994	(99.994 ohms)
about 1 sec.		measured resistance (hundredths place not displayed)	

6. Press down the ENT switch; the alarm sounds, sampling begins and the display is counted up from 1 to 99.
7. When sampling is finished, the result of the measurement is displayed.

00.001	(100.001 ohms)

8. Press the ENT switch; then repeat steps 3 thru 7. If the difference between the first measuring result (above) and the second measuring result is less than +0.001 ohm repress the ENT switch. If it is not within this range, then repeat steps 4 thru 8.

(4) TEMPERATURE OFFSET (locally)

An offset can be added to the temperature derived from sensor 1.

1. Place the FUNCTION switch in the SENSOR 2 position (switch position #6). The display should look something like the one below.

0 –	➡	00.00
about 1 sec.		water temperature offset

2. With the▲/▼switch set an offset. Pressing and holding the switch for 4 seconds or more will yield 0.1°C increments, while holding it down for more than 8 seconds will yield 1°C intervals.

3. Push down the ENT switch; the alarm sounds, indicating registration of the offset. If the FURUNO Printer FP-70 is connected, all registered data is fed to the FP-70 and then the display looks something like the one shown after step 1.

(5) ENTERING TEMPERATURE MEASURING CIRCUIT SLOPE (Constant A)

Whenever the code for memory error is displayed; for example, due to discharged battery, the following two countermeasures are available.

① Push down the ENT switch to continue operation. Because this countermeasure uses the default value of sensor 1, water temperature measuring accuracy is reduced.

② Perform memory clear; then reenter the resistance in ohms @ 0°C of sensor 1. Then, enter measuring circuit slope (constant A) and offset (constant B; enter as prescribed on the next page). Thereafter full temperature measuring accuracy is restored.

1. Place the FUNCTION switch in the SENSOR 2 position (switch position #7). The display should look something like the one below.

CmP 40	➡	1.0000
about 1 sec.		temp. measuring circuit slope

2. With the ▲/▼ switch, set the slope (constant A), which is recorded on the label attached to the inner side of the cover.

3. Press down the ENT switch; the alarm sounds, indicating the slope (constant A) is registered in the memory.

(6) ENTERING TEMPERATURE MEASURING CIRCUIT OFFSET (Constant B)

If reentry of the temperature measuring circuit slope (constant A) is made, reentry of the measuring circuit offset (constant B) must also be made. This is normally done with a 100 ohm resistor connected, however it may be performed manually by the following procedure.

1. Place the FUNCTION switch in the "REMOTE" position. The display should look something like the one below.

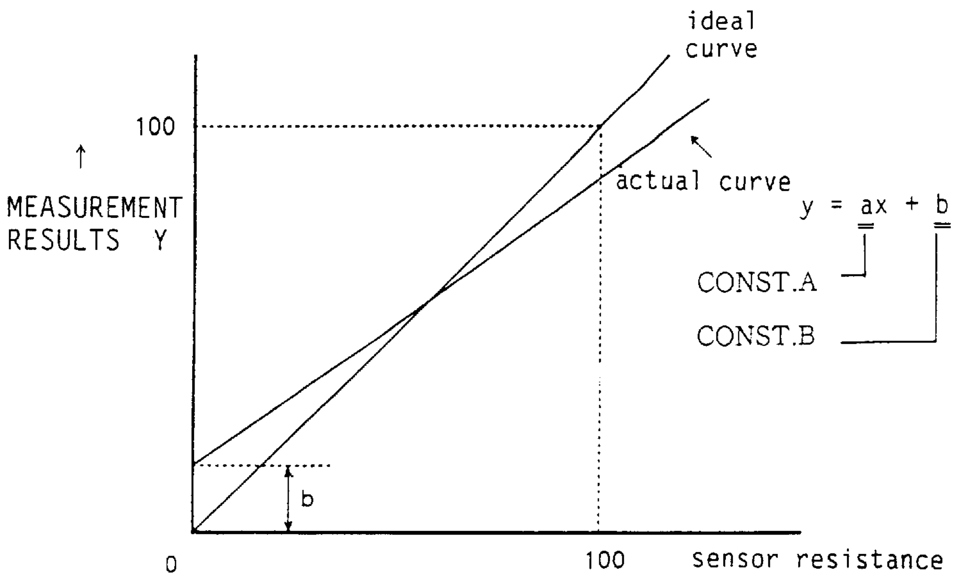
CmP 50	➡	0.0000
about 1 sec.		temp. measuring circuit offset

2. With the ▲/▼ switch, set the offset (constant B), which is recorded on the label attached to the inner side of the cover.

0.0012

3. Press down the ENT switch; the alarm sounds, indicating the offset (constant B) is registered in the memory.

REFERENCE



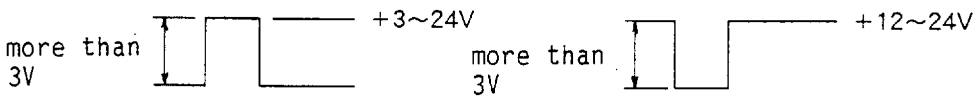
APPENDIX 3 ECHO SOUNDER WATER TEMPERATURE MARKER

If the TI-20 is interfaced with the Interface unit TI-2003, a water temperature marker, scale marker and present alarm data can be superimposed on the echo sounder picture or recording.

A) Connection Conditions

1) 12V±4V, 30mA power is taken from the echo sounder.

2) The following trigger pulse is taken.



3) Pulse generation rate is 14-570 times/minute.

For further information about the Interface unit see your agent or dealer.

B) Recording

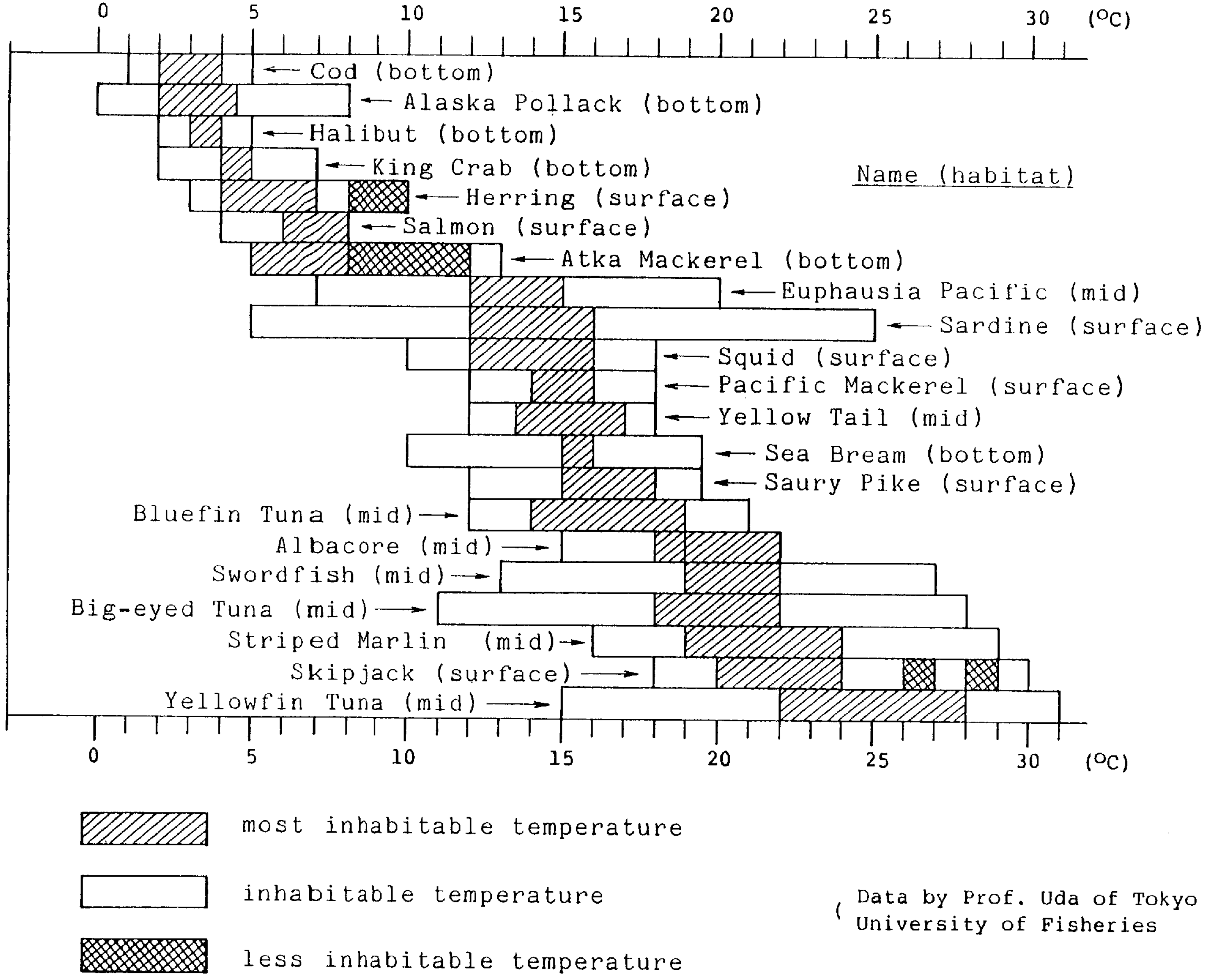
Marker	Marking Method	Resolution	Recording Range
Temp. Marker	solid line	0.01°C	-5 to 40°C
Scale Marker	solid line	1°C/5°C	full scale † 10°C/40°C
Alarm Data Marker	broken line	0.01°C	-5 to 40°C

† The scale marker recording range, either 10°C (scale mark every 1°C) or 40°C (scale mark every 5°C), depends on the setting of an internal DIP switch.

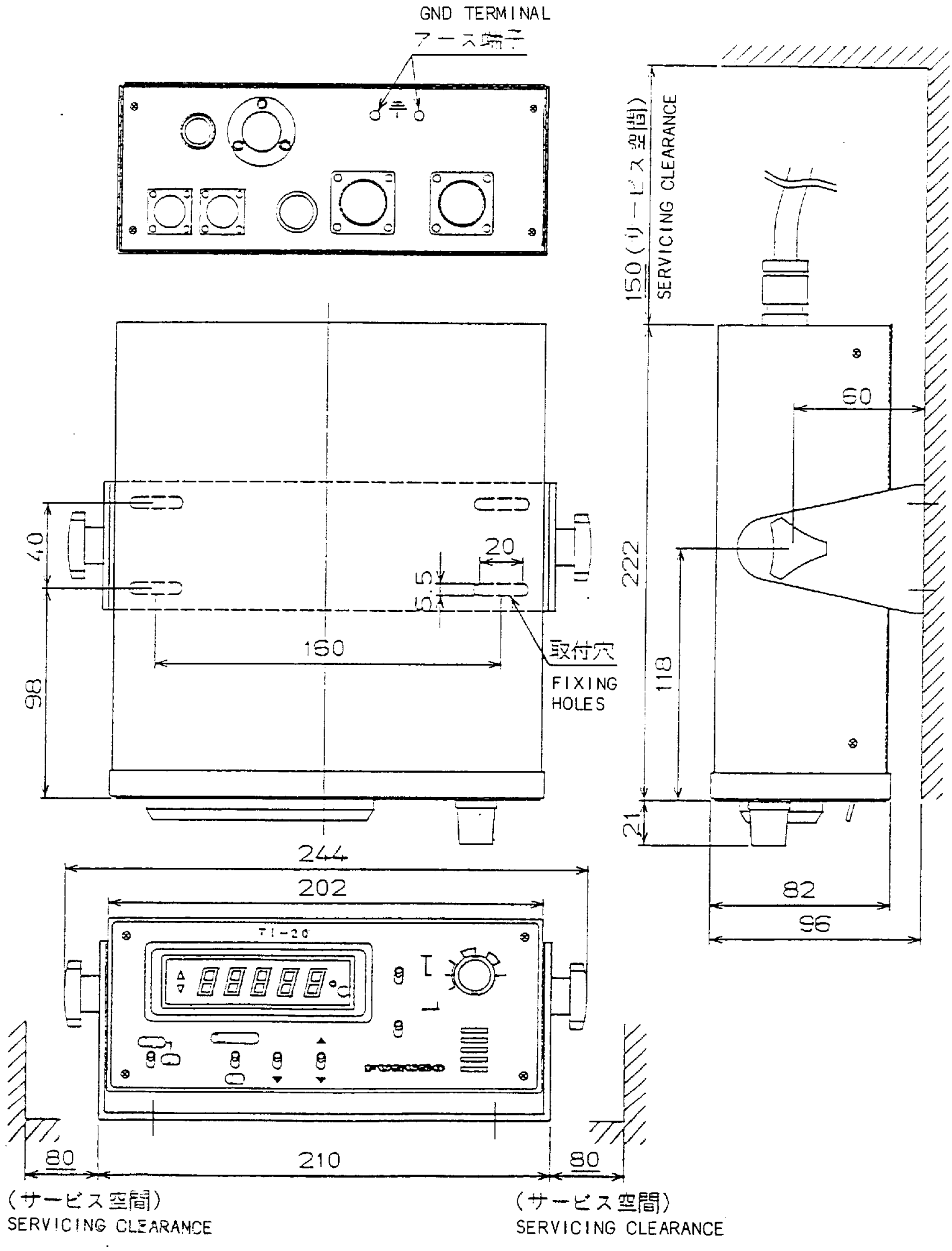
C) Chart Shift

There are times when the temperature marker may hinder interpretation of the echo sounder picture or recording. In such a case the marker can be shifted to a location 5°C higher than the actual temperature. Press the CHART SHIFT key on the front panel of the TI-20, and the marker location is shifted. Remember that in this condition the temperature shown is not the actual one, but 5°C higher.

APPENDIX 4 INHABITABLE TEMPERATURE RANGES OF REPRESENTATIVE FISH SPECIES



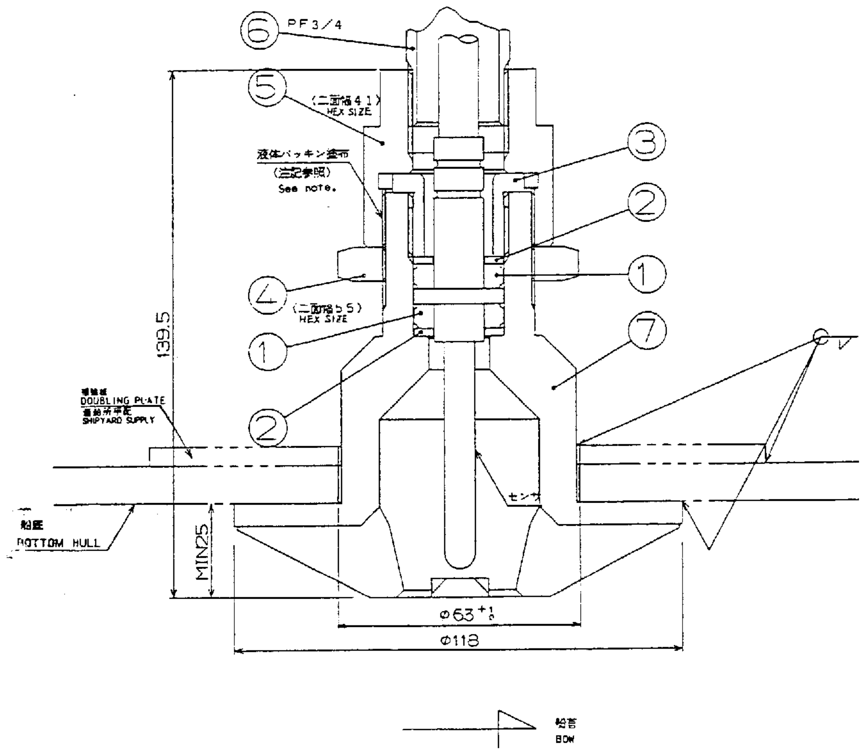
(Data by Prof. Uda of Tokyo University of Fisheries)



品番 ITEM	品名 NAME	材質 MATERIAL	数量 Q'TY	図番 DWG.NO.	摘要 REMARKS

承認 APPROVED	JUNE. 26. '87 T. NAKANO	三角法 THIRD ANGLE PROJECTION		名称 TITLE	水温計 外寸図
検図 CHECKED	June. 26. '87 I. Amano	尺度 SCALE	1/3	TI-20	TEMPERATURE INDICATOR
製図 DRAWN	26. 6. '87 Oyamat c	重量 WEIGHT	2.1 kg	図番 DWG. NO.	C4311-011-A

FURUNO ELECTRIC CO., LTD.



注記

液体パッキンはスリーボンド

溶剤タイプ(1104)

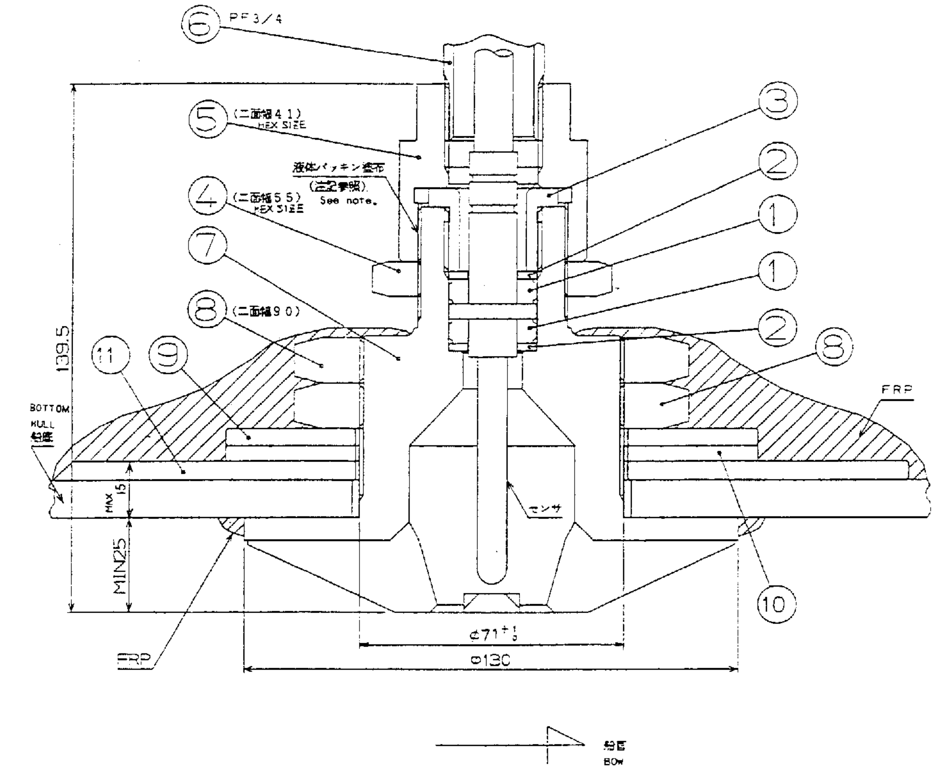
相当品とする。

Note: Apply adhesive
#1104 or equivalent.

品番 ITEM	品名 NAME	材質 MATERIAL	数量 Q'TY	図番 DWG.NO.	摘要 REMARKS
7	センサー取付体 (1) SENSOR MOUNT (1)	SS41B	1	14-035-3111-5	LB 処理
6	ニップル (1) NIPPLE (1)	SGP	1	LFH-9146-0	MFZn4-C
5	カップナット CAP NUT	SS41	1	14-035-3105-1	MFZn4-C
4	ロックナット (1) LOCK NUT (1)	SS41	1	14-035-3104-1	MFZn4-C
3	締付グランド GLAND	C3602B	1	14-035-3103-0	MBCr2
2	座金 (1) F.W. (1)	SUS304	2	14-035-3102-0	
1	パッキン (1) PACKING (1)	CR	2	14-035-3101-0	

TI-20

承認 APPROVED	SEP.29.'87 T.NAKANO	三角法 THIRD ANGLE PROJECTION		名称 TITLE	センサー取付金具(鉄船用) TEMPERATURE SENSOR INSTALLATION (STEEL BOAT)
検図 CHECKED	SEP.29.'87 I.AMANO	尺度 SCALE	1/2		
製図 DRAWN	23.7.'87 Okamoto	重量 WEIGHT	[illegible] kg	図番 DWG.NO.	C4311-012-C



注記
液体パッキンはスリーボンド
溶剤タイプ(1104)
相当品とする。

Note: Apply adhesive #1104 or equivalent.

品番 ITEM	品名 NAME	材質 MATERIAL	数量 Q'TY	図番 DWG.NO.	摘要 REMARKS
11	補強板 DOUBLING PLATE	SUS304P	1	14-035-3205-0	造船所手配 SHIPYARD SUPPLY
10	パッキン (2) PACKING (2)	布入りCR	1	14-035-3204-0	
9	座金 (2) F.W. (2)	SS41	1	14-035-3203-0	MFZn4-C
8	ロックナット (2) LOCK NUT (2)	SS41	2	14-035-3202-0	MFZn4-C
7	センサー取付体 (2) SENSOR MOUNT (2)	BC2	1	14-035-3201-5	脱脂
6	ニップル (1) NIPPLE (1)	SGP	1	LFH-9146-0	MFZn4-C
5	カップナット CAP NUT	SS41	1	14-035-3105-1	MFZn4-C
4	ロックナット (1) LOCK NUT (1)	SS41	1	14-035-3104-1	MFZn4-C
3	締付グランド GLAND	C3602B	1	14-035-3103-0	MBCr2
2	座金 (1) F.W. (1)	SUS304	2	14-035-3102-0	
1	パッキン (1) PACKING (1)	CR	2	14-035-3101-0	

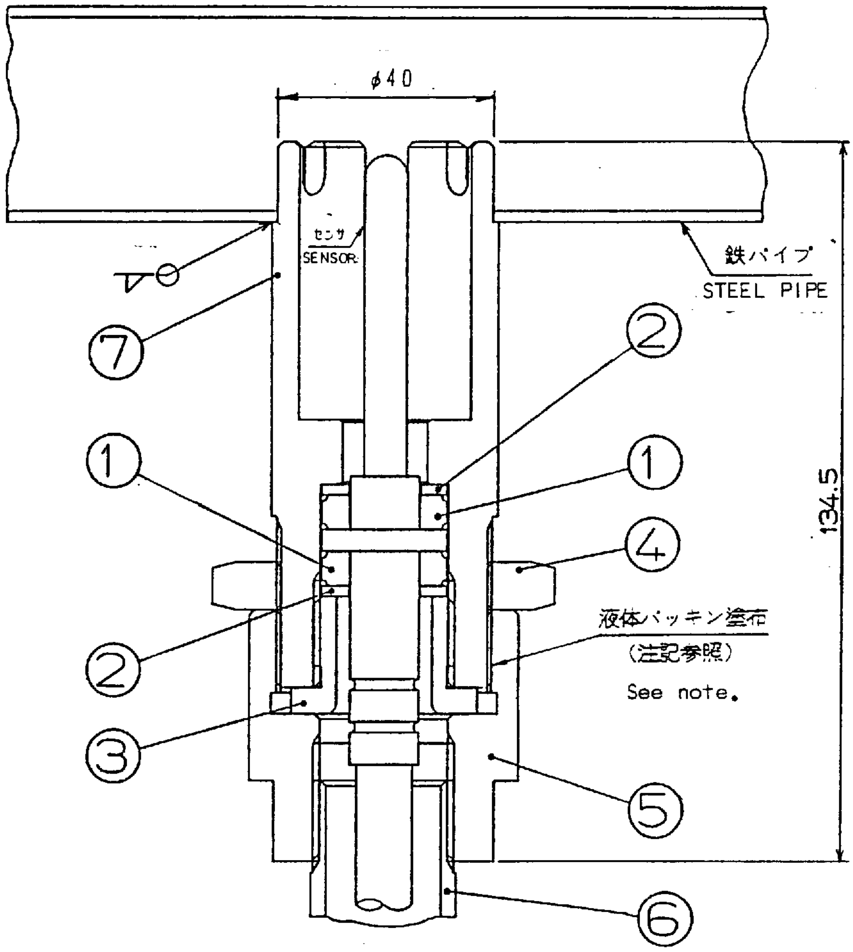
TI-20

承認 APPROVED	SEP. 29. '87 T. NAKANO	三角法 THIRD ANGLE PROJECTION		名称 TITLE	センサー取付金具 (FRP船用) TEMPERATURE SENSOR INSTALLATION (FRP BOAT)
検図 CHECKED	SEP. 29. '87 I. AMANO	尺度 SCALE	1/2		
製図 DRAWN	23. 7. '87 [illegible]	重量 WEIGHT	kg	図番 DWG. NO.	C4311-013-C

FURUNO ELECTRIC CO., LTD.

FURUNO

D－4



注記

液体パッキンはスリーボンド溶剤タイプ（１１０４）
相当品とする。

Note: Apply adhesive #1104 or equivalent.

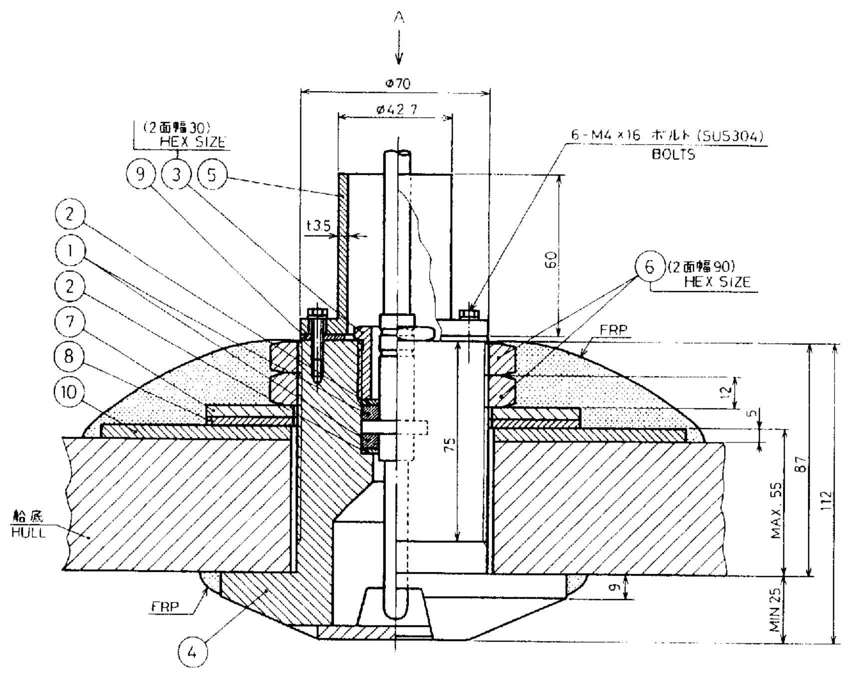
品番 ITEM	品名 NAME	材質 MATERIAL	数量 Q'TY	図番 DWG.NO.	摘要 REMARKS
7	センサー取付体 (3) SENSOR MOUNT (3)	SS41B	1	14-035-3301-0	LB処理
6	ニップル (1) NIPPLE (1)	SGP	1	LFH-9146-0	MFZn4-C
5	カップナット CAP NUT	SS41	1	14-035-3105-0	MFZn4-C
4	ロックナット (1) LOCK NUT (1)	SS41	1	14-035-3104-0	MFZn4-C
3	締付グランド GLAND	C3602B	1	14-035-3103-0	MBCr2
2	座金 (1) F.W. (1)	SUS304	2	14-035-3102-0	
1	パッキン (1) PACKING (1)	CR	2	14-035-3101-0	

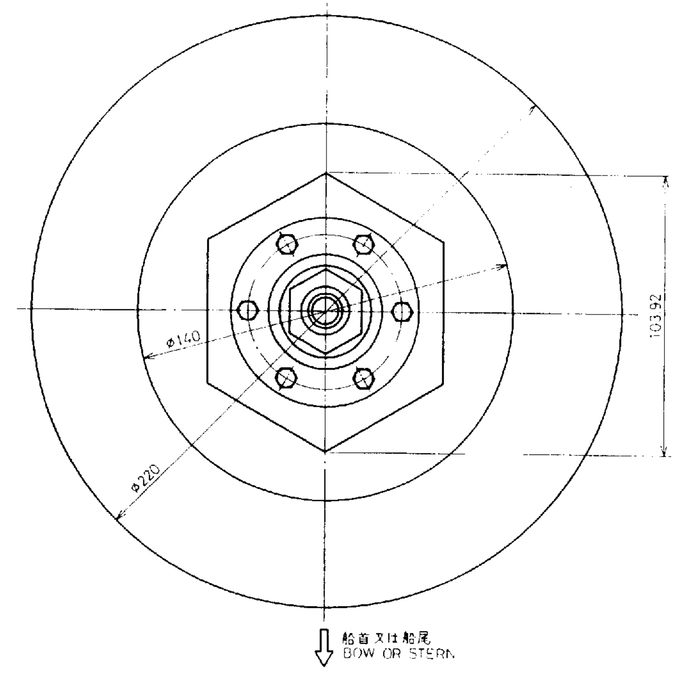
TI-20

承認 APPROVED	SEP・29・'87 T. NAKANO	三角法 THIRD ANGLE PROJECTION		名称 TITLE	センサー取付金具（鉄パイプ用） TEMPERATURE SENSOR INSTALLATION (STEEL PIPE)
検図 CHECKED	SEP・29・'87 I. AMANO	尺度 SCALE	/		
製図 DRAWN	23・7・'87 Okamoto	重量 WEIGHT	1.3 kg	図番 DWG. NO.	C4311－014－A

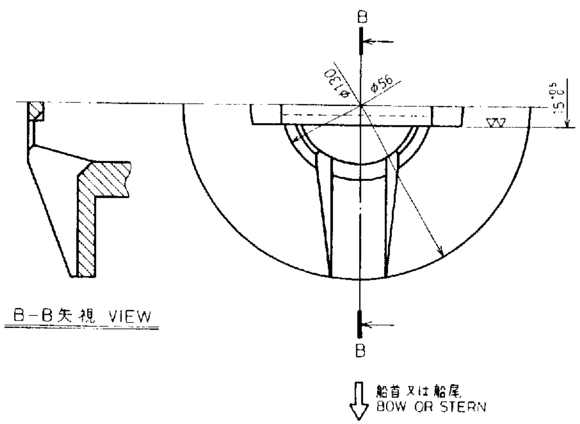
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A 矢視図 SIDE VIEW

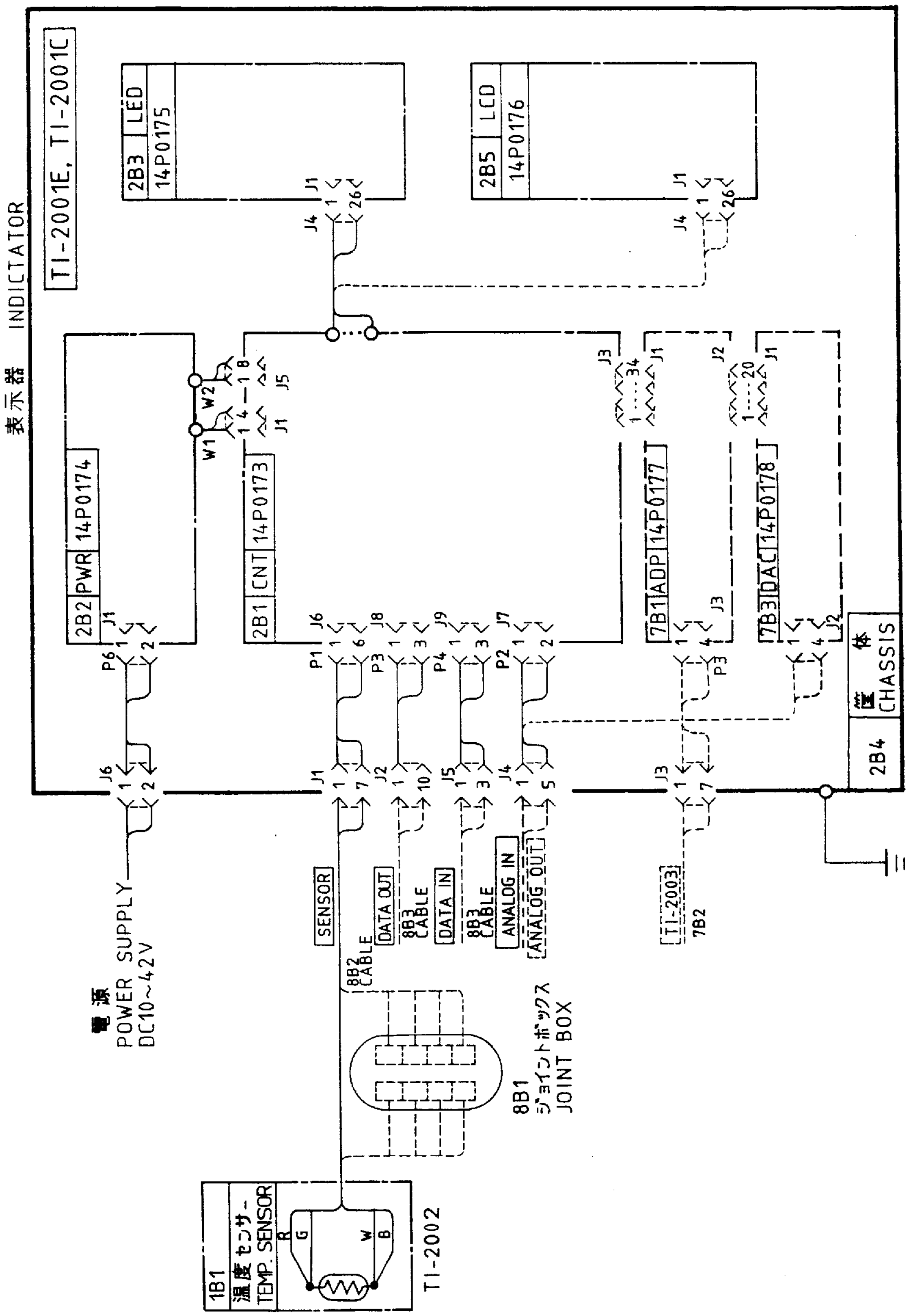


B-B矢視 VIEW

品番 ITEM	品名 NAME	材質 MATERIAL	数量 Q'TY	図番 DWG.NO.	摘要 REMARKS
10	補強板 DOUBLING PLATE	SUS304	1	14-035-3205-0	造船所手配 SHIPYARD SUPPLY
9	パッキン PACKING	布入りCR	1	14-035-3604-0	
8	パッキン(2) PACKING(2)	布入りCR	1	14-035-3204-0	
7	座金(2) F.W.(2)	SS41	1	14-035-3203-0	MFZn4-C
6	ロックナット LOCK NUT	SS41	2	14-035-3202-0	MFZn4-C
5	ニップル NIPPLE	SGP 32A	1	14-035-3603-0	MFZn4-C
4	センサー取付体(6) SENSOR MOUNT(6)	BC2	1	14-035-3601-0	脱脂
3	締付グランド GLAND	C3602B	1	14-035-3602-0	MBCr2
2	座金(1) F.W.(1)	SUS304	2	14-035-3102-0	
1	パッキン(1) PACKING(1)	CR	2	14-035-3101-0	

承認 APPROVED	JUN.23.'89 T.NAKANO	三角法 THIRD ANGLE PROJECTION		名称 TITLE	センサー取付金具(FRP厚底船用) TEMPERATURE SENSOR (FOR THICK FRP HULL)
検図 CHECKED	JUN.23.'89 M.SAITO	尺度 SCALE			
製図 DRAWN	Jun.23.'89 OKAMOTO	重量 WEIGHT	4.2 kg	図番 DWG.NO.	C4311-G01-A

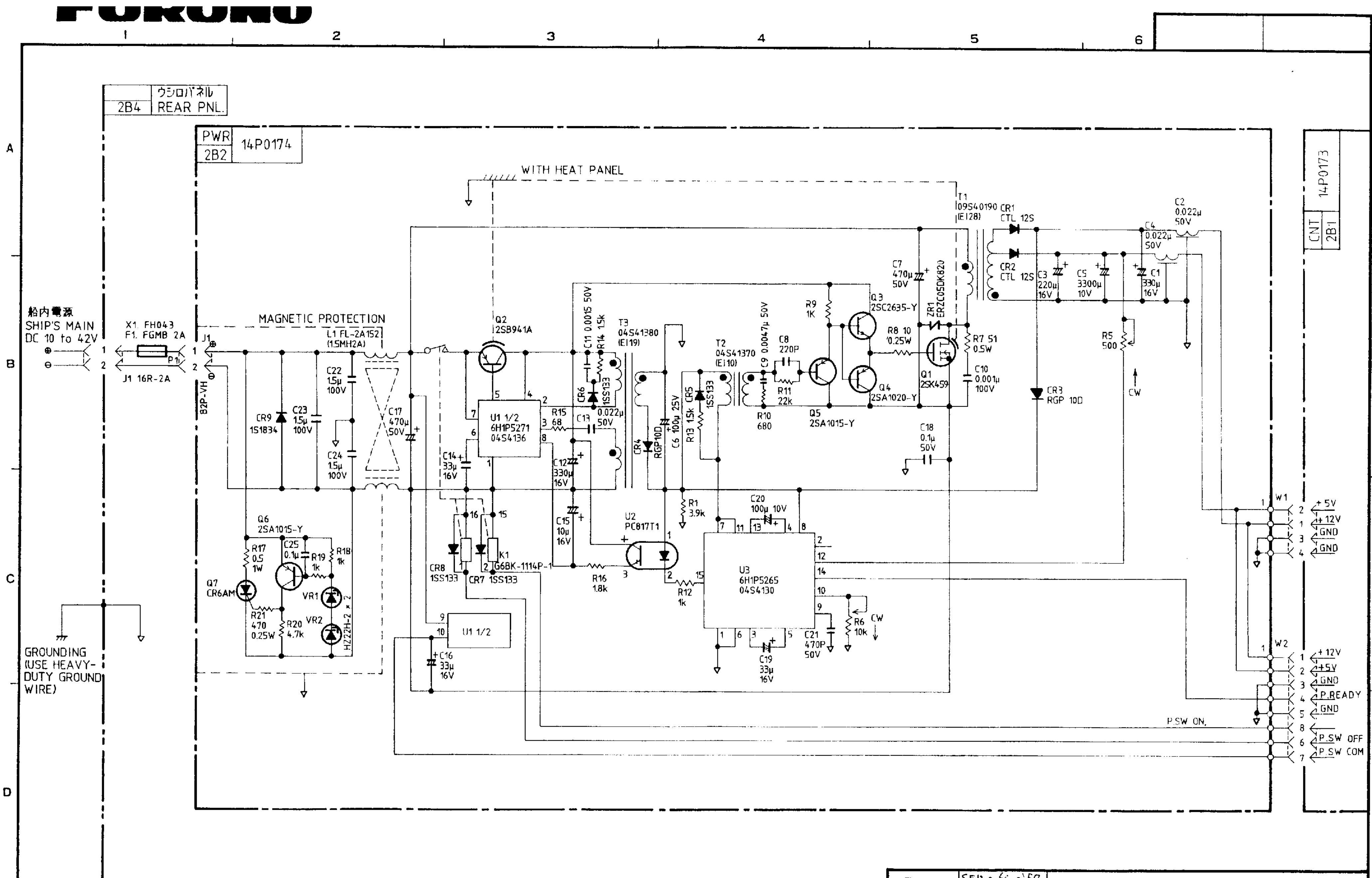
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品番 ITEM	品名 NAME	材質 MATERIAL	数量 Q'TY	図番 DWG.NO.	摘要 REMARKS

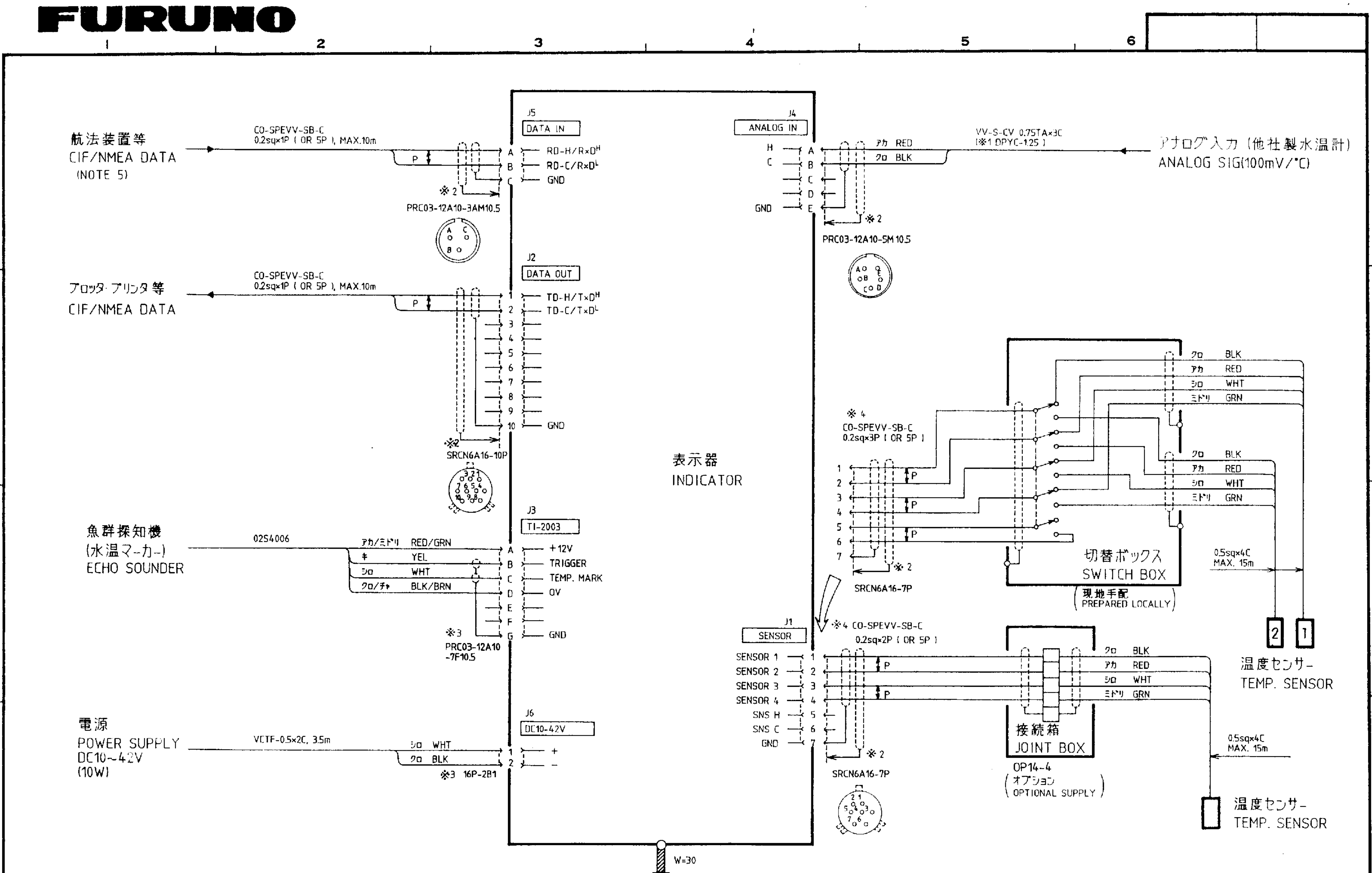
承認 APPROVED	SEP. 8. '87 T. NAKANO	三角法 THIRD ANGLE PROJECTION	名称 TITLE 水温計総合回路図
検図 CHECKED	Sep. 8. '87 I. Amano	尺度 SCALE /	TI-20 TEMPERATURE INDICATOR
製図 DRAWN	Sept. 1. '87 Okamoto	重量 WEIGHT kg	図番 DWG.NO. C4311-015-A

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承認 APPROVED	Sep. 4. '87 T. NAKANO	名称 TITLE	TI-20	電源回路 POWER SUPPLY
検図 CHECKED	Sep. 4. '87 I. Amano			
製図 DRAWN	Sep. 4. '87 [illegible]	図番 DWG.NO.	C4311-018-A	

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NOTE
※ 1. 造船所支給。SHIPYARD SUPPLY.
※ 2. ケーブル鎧装はコネクタクランプで接地する。GROUND THE ARMOR THRU CONNECTOR CLAMP.
※ 3. 出荷時コネクタ取付済。CONNECTOR PLUG FACTORY FITTED.
※ 4. センサーケーブル(センサーから表示器まで)は最大50m以下のこと。
SENSOR CABLE FROM SENSOR TO INDICATOR SHOULD BE LESS THAN 50m.
※ 5. DSR制御している機器 (FSN-70, LC-70, LC/LAC-3000 etc.) の場合DSRをDTRにリンクする。
LINK BETWEEN DSR AND DTR IF THE DATA TRANSMISSION IS CONTROLLED BY DSR. (FOR FSN-70, LC-70 etc.)

承認 APPROVED	Nov.10.'87 T. NAKANO	名称 TITLE	デジタル水温計 相互結線図 INTERCONNECTION DIAGRAM
検図 CHECKED	Nov.10.'87 T. Yoyama	TI-20	
製図 DRAWN	Nov.10.'87 I. AMANO	図番 DWG.NO.	C4311-019-E